TKP4550/TKP4551 PROSESS-SYSTEMTEKNIKK (PROCESS SYSTEMS ENGINEERING)

Coordinator: Sigurd Skogestad

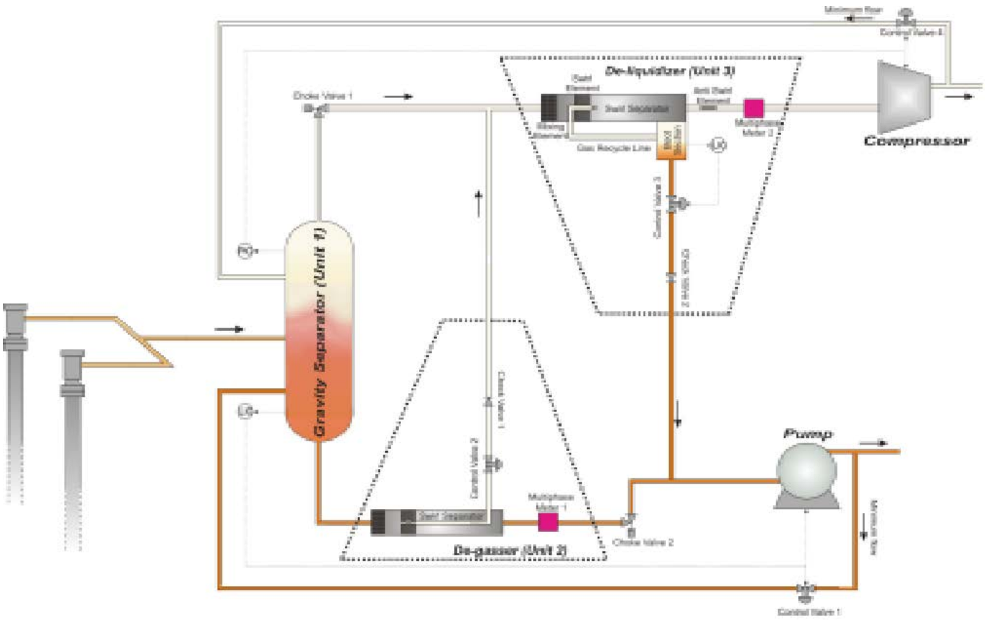
Project proposal from Professor Sigurd Skogestad: sigurd.skogestad@ntnu.no

69. Modelling and optimization of compact subsea separators

In order to be able to produce hydrocarbons economically from reservoirs under difficult circumstances, such as ultra-deepwater conditions or low reservoir pressure, is is necessary to separate oil, gas, and water at the sea floor. This subsea separation enables efficient and economic transport over long distances, and also reduces the back pressure on the reservoir, which leads to increased production.

However, for economic reasons, the separators used subsea are built very compactly, and this comes with unique operational challenges. These compact processes are often very coupled, and due to the relatively small dimensions, they exhibit fast dynamics, which can be challenging when controlling the process

The objective of this thesis is to model and optimize a compact subsea separation process for control purposes. We will start from the model described in Ellingsen (2007), which can be found at http://www.nt.ntnu.no/users/skoge/diplom/prosjekt07/ellingsen/ , see also the figure below:



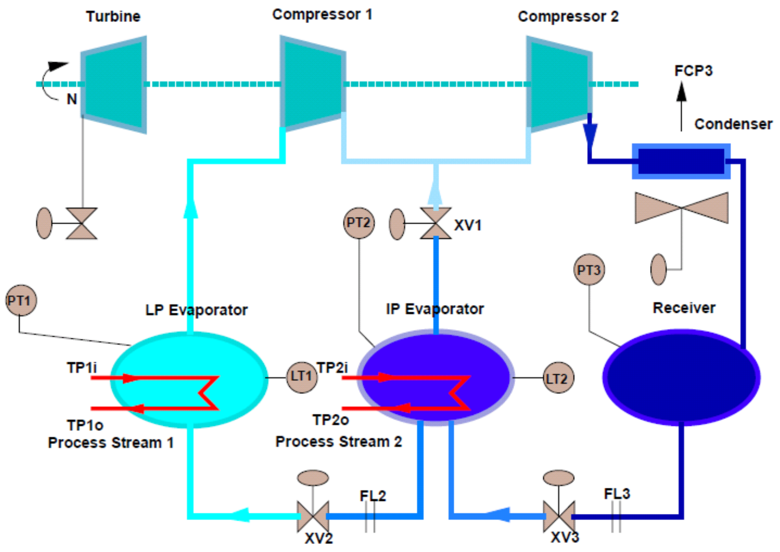
In this process liquid and gas coming from a well are to be separated, and the separation is done in two stages, where first the bulk separation is done in the Gravity separator, and then the gas-rich phase is sent to the deliquifier, and the liquid-rich phase is sent to the degasser.

The operational objective is adjust the available valves in such a way that the gas content in the liquid stream to the pump is minimized.

We are looking for someone who likes to programm in matlab or a similar language, with good mathematical skills the ability to work independently. The main focus of the project is on the modeling and steady state simulation of the process. In a possible follow-up master project, the focus will be on using the model for finding optimal operation strategies. The simulations will be done in the modeling languages matlab or ampl.
Supervisor: Professor Sigurd Skogestad, co-supervisor: Johannes Jäschke

70. Modelling and optimization of a 2-stage compressor train

This project has been suggested to us by Exxon Mobil, and it is similar to a process they want to optimize in one of their plants. The goal of this project is to model and optimize a 2-stage compressor cooling system with propylene as cooling fluid, see figure below (A very detailed process description can also be found under this hyperlink: :http://www.nt.ntnu.no/users/skoge/publications/thesis/more/Basel_Asmar_PhD99/CH3.pdf).



A process stream is cooled down by a two-stage refrigeration system, where most of the cooling is performed at the low pressure (LP) evaporation stage, and the remaining heat is removed from the process stream in the intermediate pressure (IP) evaporator. The amount of cooling at the high and the intermediate pressure level can be adjusted by manipulating the control valves (XV1,XV2,XV3). The objective of this project is to find an operation strategy, which adjusts the control valeves such that the total shaft work W is minimized. This correspond to minimizing the total energy consumption.

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Supervisor: Professor Sigurd Skogestad, co-supervisor: Johannes Jäschke

71. Optimization using ideas from self-optimizing control

Most emphasis in optimization is on the optimization algorithm, but structural ddecsions regarding the choice of the optimization and variables and the parameterization of the probkem may be more important. Apllication will be on the optimization of energy storage using hot water in houses and on MPC.
Supervisor: Professor Sigurd Skogestad, co-advisor: Vinicius de Oliveira

72. Dynamics and plantwide control of the Dynea silver formaldehyde process

For more information contact Sigurd Skogestad.
Supervisor: Professor Sigurd Skogestad

73. Optimal location of the throughput manipulator

This is a very important decision when designing a control system, yet little work has been done on finding the best location. In this project, we especially want to study its effect on avoiding the "snowball effect".
Supervisor: Professor Sigurd Skogestad

74. Alternative implementations of midranging control

The two main alternatives are a cascade implementation and a parallell implementation, and the two alternatives will be tested on a heat exchanger with bypass and other process examples.
Supervisor: Professor Sigurd Skogestad

75. Expected problems when pairing on negative RGA-elements

The basis for this project is that it is not clear what happens if one pairs on a negative RGA. This will be a mix between simulation (in Simulink) and theory.

Background: Pairing on a negative steady-state RGA-element may give good decentralized control performance, but there are potential risks.
First, note that if one pairs on a negative RGA, then one cannot tune the controllers using independent designs (where each loop is tuned separately with the other loops in manual), because one would get instability when all loops are closed.
Second, consider sequential loop closing, which is probably more common practise. In this case, pairing on a negative RGA is claimed to result in instability, and the objective of this work is to study this in more detail.
Supervisor: Professor Sigurd Skogestad

75b. New method for temporary heating or cooling of liquids with minimal energy consumption and CO_2 emission

In many production processes there is a need for short-term heat treatment. For example for the pasteurization of milk and other food materials, a liquid is heated to above 70 degrees C for a couple minutes in order to inactivate enzymes and kill microorganisms, whereafter the liquid is cooled again in order to retain its nutritional value. In other processes there is, conversely, a need for temporary cooling, for example to precipitate or crystallise dissolved components. In either case, both the heating process and the cooling process are energy-demanding, and therefore represent considerable emission of CO_2 , directly or indirectly. Moreover, they often use electricity or steam, which is not always available.
The proposed project consists of 1) setting up a simulation model for a newly proposed, simple method for temporary heating or cooling of a liquid, with minimal use of energy and thus minimal CO_2-footprint, 2) to use this simulation model to assess the feasibility of the proposed method and 3) to provide a first attempt at optimizing the model thermodynamically with respect to essential construction parameters.
Supervisor: Professor Sigurd Skogestad and Harald Martens, ITK

Project proposals from prof. II Krister Forsman, process control specialist at Perstorp

76. Cascade control

In a traditional cascade loop, a disturbance in the slave control loop leads to a disturbance in the master loop which has an ”unnecessary” undershoot.
This type of behavior is impossible to achieve without modifying the structure. Is there a modification of the structure that does not have this effect?
A different question: Is it possible to quantify when cascade control should be used?
Supervisors: Professor Sigurd Skogestad and professor II Krister Forsman at Perstorp

77. Implementation of ratio control

Ratio control can be implemented in several different ways and the objective is to compare these. One issue is how we handle saturation, and another issue is how to handle nonlinearity caused by changes in the operating point.
Supervisors: Professor Sigurd Skogestad and professor II Krister Forsman at Perstorp

78. Variance minimizing control

In applications, occasionally the control valve will saturate, i.e. go to 0% or 100%, in which case the controller is not active any more. Normally, this just means that we are facing a process design problem, and there is nothing to be done about the situation from a control

point of view. However, in some applications it may be as important to reduce variations in the process variable as it is to keep its value close to the setpoint.
To solve this compromise we may consider modifying the working setpoint slightly so that we get back into a controllable situation, but also monitor when we can start going back to the target setpoint.
Supervisors: Professor Sigurd Skogestad and professor II Krister Forsman at Perstorp

79. Industrial control case at Perstorp

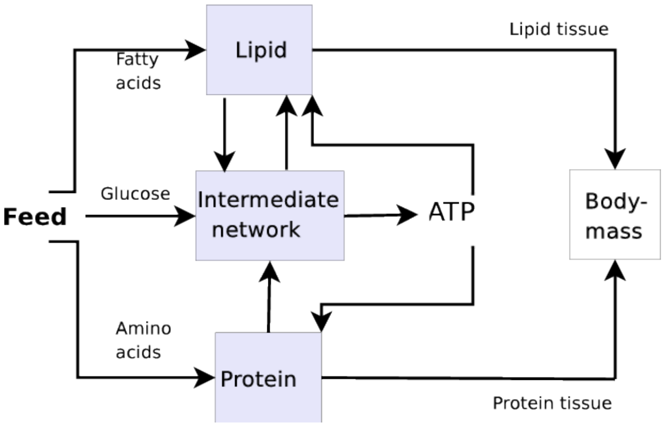
There are several possible cases, including distillation processes.
Supervisors: Professor Sigurd Skogestad and professor II Krister Forsman at Perstorp

Project proposals from Associate Professor Nadav S. Bar: nadi.bar@ntnu.no

Systems Projects, related to biology 2014

80. Simulation and numerical optimization of a dynamic model of growth (System biology: applied modeling)

A novel model that predicts the growth of fish, given the feed type and environmental conditions, has been developed during 2003-2009. The model traces the nutrients, proteins and fat, through the metabolic processes of the body, and basically it is a set of ordinary differential equations. It was implemented in Matlab code, using a constant time step, first order Euler integration method to solve the differential equations.



However, this method for solving the differential equations is very inefficient, and a more practical implementation is needed.

The main goal of this project is to optimize the integration method of the model, using a combination between a constant time-step and Matlab's ODE time variable solvers (ode45, ode15s). The project is interesting since it attempts to give a practical, industrial, applied solution to a theoretical model. If the program (the implementation of the model) could be optimized and made efficient, it will have a great value to the aquaculture field, both in study fish development and design more healthy fish feed.